Skills, Franchise and Industrialization

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Abstract

In this paper the skill distribution is proposed as being fundamental for technological transitions, besides the economic and political variables normally considered. The setting is an endogenous growth model with non-overlapping generations, where agents are heterogeneous with respect to wealth, skills and political power. It is shown that the skill distribution is as important as the initial wealth distribution and the type of political regime in determining the subsequent economic development of a country. The results indicate that the time horizon matters when judging which institutional framework has most potential to generate a technological transition. Moreover, it is shown that there is no setup of initial characteristics that most favors a country's development in all situations. The outcomes of the model are consistent with historical data from 1820 to 1913 for 23 countries.

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1 Introduction

Why did some countries become industrialized during the 19th century, while others did not? There are several theories trying to explain the differences in development between countries that originally started off from a similar technological level. Innovations, learning-by-doing and stable property rights are only a few of the sources suggested to generate sustained growth.

This paper proposes another explanatory variable for development, namely the skill distribution. More specifically, the distribution of skills is argued to be crucial for technological transitions, e.g. from an agrarian to an industrialized economy (or from an industrial to a post-industrial economy). A transition is characterized by a shift from an old technology to a new one. For this shift to occur it has to be more profitable to use new technology than old one. The gains from investing in new technology generally depend both on agent-specific characteristics, such as skills and personal wealth, as well as on public investments supporting the transition process. The extent of the latter is decided upon in a political process. For example, a higher share of enfranchised individuals in the population increases, ceteris paribus, the amount of public goods provided - given the normal assumption of a skewed income distribution. Since public investments are central for the investment incentives, it is important to model the political regime explicitly to understand the technological transition. The preconditions for an industrial revolution are therefore affected by the political system and how this system is related to the distribution of skills over different income groups.

Skills enter the model as an additional dimension with respect to which individuals are heterogeneous, besides personal wealth and political rights. In period 0 the economy is assumed to be agrarian in the sense that earned income is unrelated to agent-specific skills. The absence of human-capital in the production function of the one and only sector in the economy is motivated by the observation that the return to human capital is almost non-existent in rural economies.[1] At the end of period 0 the country is hit by a positive exogenous shock, that allows a new, human capital-intensive sector to arise. The return

[1] See Lindert & Williamson (1985) for a discussion of the case of the Industrial revolution in Europe.

to investment in this growth-promoting sector is directly proportional to the skillfulness of the agent. The shock can be viewed as a revolutionary technological innovation, a positive oil crisis or such like.[2] The shock provides for a new type of government intervention, since it for example is necessary to modify the legal system, build new infrastructure and expand schooling in order for the transition to an industrialized society to take place. Tax revenues finance these public expenses. The tax rate is decided upon in a political process. The political regime in this model is characterized as either democratic or authoritarian. In the latter case there are wealth qualifications for voting. This assumption is to be viewed as descriptive of the fact that while the rich usually have political influence, it is also true that politicians in autocracies often get wealthy.

So what is the role of the skill distribution in the transition process? On the one hand, the skill level determines the willingness of an individual to contribute to public goods; and on the other, it influences the return to investments in the human capital-intensive sector, and therefore the growth of aggregate income.

The simulations of the model generate two broad conclusions. First, there is no setup of initial characteristics that most favors a country's level of development in all situations; second, the time horizon matters when judging which institutional framework has most potential to generate technological transformations. Regarding the importance of the skill level it is established that initially democratic regimes require relatively low levels of skills to industrialize. Considering authoritarian regimes it is possible to indicate, at least in principle, which characteristics are most important for development. The authoritarian regime that performs best has an initially flat wealth distribution and high-skilled wealthy individuals. The economy that is the last to become industrialized in all circumstances is the authoritarian regime with low-skilled wealthy agents and an initially skewed wealth distribution.

These theoretical results are confronted with historical data from 1820 to 1913. This period is particularly apt for checking the implications of the model since countries did

[2] Another way of putting it is to view the shock as the trigger of one of those long waves hypothesized to hit the world economy every fifty years by economists like Schumpeter and Kondratieff. See Maddison (1991).

not engage in direct redistribution to any significant extent.[3] The outcomes of the model are shown to be at least weakly consistent with data. But as in most cases some important factors have been left out to isolate the effects of those factors being studied and that should be remembered. Examples of such important factors are international trade, population growth, natural resources, etc. This paper belongs to the literature of politics, endogenous growth and inequality. As in Alesina and Rodrik (1994), Persson and Tabellini (1994), Saint-Paul and Verdier (1993) and Perotti (1993) economic development is directly influenced by the political outcome. Moreover, like in the two latter papers, redistribution – here indirect redistribution in the form of public services – can be conducive to growth. This is in line with the stylized fact reported in Benabou (1996) and Persson and Tabellini (1997) that institutions protecting property rights enhance development, and more in general with the idea that sound governmental involvement is necessary for a successful transition.

The paper is structured as follows. Section 2 gives the economic and political setting of the model. Economic and political equilibria are derived in section 3. The simulation of the model is presented in section 4, starting by exposing the basic assumptions. Empirical evidence is presented in section 5. The paper is concluded with a discussion of the results and possible extensions.

2 The Economic and Political Setting

2.1 Population structure

Consider a stationary population of non-overlapping generations normalized to one. There are no intergenerational conflicts. Each agent lives for one period. At birth, an agent is characterized by the bequest received from her parent and her skill level. The bequest received by an agent belonging to generation t is b_{t-1}^i, where $i \in \{R, P\}$ indicates whether the agent's family was rich or poor in period 0. The share of the population receiving b_0^R and b_0^P in period 0 is z and $(1-z)$, where $z \in (0,1)$. An agent's skill level, e^j, is the sum of s^j, her competence as entrepreneur, and w_0, the average education level of the

[3] See Flora and Alber (1987) for a discussion of the development of public expenditures.

population in period 0:

$$e^j = w_0 + s^j \ .$$

Agents with a high ability of enterprising have the competence endowment s^{high}, while the remaining agents with less abilities in this respect have s^{low}. It is assumed that the competence level is hereditary. An agent is said to be high-skilled if and only if she has the competence level s^{high}. This yields a total of at most four groups of agents, characterized by differences in skills and/or wealth.

Agents have two interests in life: to consume and to leave a bequest. Preferences are Cobb-Douglas in consumption and bequest for every combination of social group i and skill level j in generation t, that is[4]:

$$u(c_t, b_t) = (c_t)^{\gamma} (b_t)^{1-\gamma} , \tag{1}$$

where c_t is the consumption of an agent, b_t is the agent's bequest to the next generation, and $\gamma \in (0,1)$. At the end of her life, the agent gives birth to a new agent. The agent generates a life-time income, m_t, that she will use optimally by dividing it between consumption and bequests as follows:

$$\begin{aligned} c_t &= \gamma m_t \ , \\ b_t &= (1-\gamma) m_t \ . \end{aligned}$$

Hence, the indirect utility function is:

$$v(\cdot) = \gamma^{\gamma} (1-\gamma)^{1-\gamma} m_t \ . \tag{2}$$

2.2 Economic Structure

In period 0 there is only one sector in the economy, the traditional K-sector, with the following production function:

$$y_t^K = q k_t \tag{3}$$

[4]In order to simplify the notation, the notation c^{ij} is avoided. Superindexes are used only to indicate skill level and social class.

where k_t is physical capital and q is its return, which is such that $q = \frac{1}{1-\gamma}$. Letting the return to investments in physical capital be $\frac{1}{1-\gamma}$ implies, together with optimal bequest behavior, that the situation in period 0 is consistent with a steady state. The rationale is that in a so called traditional society, land and other resources have approximately the same value over time. It is assumed that there is no functioning credit market. When there are no other investment possibilities, the total amount of inherited wealth, B_{t-1}, goes to investment in physical capital, constituting the stock of physical capital.

At the end of period 0 an exogenous positive shock hits the economy. It changes the agents' sets of possibilities in the sense that it permits individuals to exploit their human capital-endowment. More precisely, this positive shock enables the emergence of a second, human capital-intensive, sector with the following production function:

$$y_t^H = A_t(e^j)^{1-\beta}\,(h_t)^{\beta}\,(g_t)^{1-\beta} \quad . \tag{4}$$

In (4) $h_t = b_{t-1}^i - k_t$ is investment of physical capital in the H-sector, g_t is per capita public services and $\beta \in (0,1)$. (g_t is discussed at length in the following section.) The shock consists in a switch of the parameter A_t from 0 to 1. Furthermore I assume that spillovers between generations are associated with production in the human capital-intensive sector. More specifically, if $t > 0$ then A_t is assumed to be a function of the share of aggregate production in the previous period, $Y_{t-1} = Y_{t-1}^K + Y_{t-1}^H$, in the following way:

$$A_t = \begin{cases} 0 & \text{if } t = 0 \\ 1 + \frac{Y_{t-1}^H}{Y_{t-1}} & \text{if } t > 0 \end{cases} \quad .$$

This implies that in $t = 1$, and all other ts preceded by periods without investments in the H-sector, $A_t = 1$, while when investments have been made by the previous generation A_t will not only be larger than 1 but also a positive function of Y_{t-1}^H. Notice that since the human capital-sector is the growth-promoting sector, increases in income are equivalent to ongoing industrialization.

It is presupposed that the sectors exist parallel to each other and do not interact during the initial transition phase analyzed in this paper. The motivation for this is that the agricultural sector continues to exist in an industrialized economy, but generally contributes to a smaller share of output than before industrialization.

2.3 Political Structure

In this paper, the political regime is either democratic or authoritarian. In the latter case there are wealth qualifications to voting. Otherwise there are no differences between the two regimes. More precisely a bequest at least equal to that of the richest group in period 0 gives the right to vote in an authoritarian regime. b_0^R is also the threshold value for all future generations. As a consequence the decisive voter always belongs to the rich in this type of regime. The inclusion of wealth qualifications in the model is motivated by strong empirical regularities indicating a positive link between income per capita and democratization. As first pointed out by Lipset (1959) "the more well-to-do a nation, the greater the chances that it will sustain democracy".

Elections are held every period, before investment decisions are made. As economic development takes place new groups of agents gain voting rights. Therefore, growth will have direct effects on franchise. Since voting rights are revised at the birth of each generation, agents do not face a trade-off between political influence and personal income.

The use of skills in the H-sector, and more generally the transition to a modern economy, calls for the provision of new public goods and services, such as educational policies, investments in infrastructure and an appropriate legal system. The modelling of public services, G_t, follows Barro (1990), where public services are complementary to private production. For simplicity, we let only production in the growth-promoting sector gain from the provision of these public services – see equation (4). Moreover, we assume that each individual in the H-sector receives a constant fraction $g_t = \frac{G_t}{n}$ of public services, where n is the population size.[5] This implies that g_t is a rival public good, which also has an aspect of excludability. g_t can therefore be interpreted to be either a publicly provided private good, as education, or a rival public good subject to congestion, as in the case of courts and infrastructure.

Inherited wealth is assumed to be the tax base. (Taxing bequests instead of for example income has the advantage of giving an explicit analytical solution for the equilibrium tax rate.) Specifically,

$$G_t = [\tau_t - f(\tau_t)] B_{t-1} , \tag{5}$$

[5]Since the population size is normalized to 1, $g_t = G_t$.

where τ_t is the tax rate such that $\tau_t \in (0,1)$ and $f(0) = 0$, $f' > 0$, $f'' > 0$. Hence, there are distortions associated with taxation, which increase more than linearly with the tax rate. As a special case, $f(\tau_t) = \tau_t^2$ will be used in order to get mathematically clearer expressions. It is assumed that the state budget has to be balanced every period.

2.4 Timing within a Period

Before solving for the optimal tax rates and investment decisions, the timing of events within generations is recapitulated.

1. When the agent is born, her innate skill level and inheritance are given.
2. The electorate is determined by the share of the population that received a bequest superior to b_0^R.
3. A vote is held over the tax rate.
4. B_{t-1} is taxed.
5. Private investment decisions are made and implemented.
6. Production and consumption take place.

3 Economic and Political Equilibrium

3.1 Investment Decision

For a single agent belonging to generation t, and for every combination of social group i and skill level j, the income generated is:

$$y_t^K + y_t^H = qk_t + A_t \left(e^j\right)^{1-\beta} (h_t)^{\beta} (g_t)^{1-\beta}$$

given the constraint that $k_t + h_t = (1 - \tau_t) b_{t-1}^i$. Taxing bequests implies that the total amount of public services for generation t will be as follows:

$$G_t^* = [\tau_t^* - f(\tau_t^*)] B_{t-1}$$

where τ_t^* is the equilibrium tax rate. The indirect utility function for an agent with bequest b_{t-1}^i and skill level e^j is:

$$v(\cdot) = \gamma^\gamma (1-\gamma)^{1-\gamma} \left\{ q \left[(1-\tau_t^*) b_{t-1}^i - h_t \right] + A_t \left(e^j \right)^{1-\beta} (h_t)^\beta (g_t^*)^{1-\beta} \right\}$$

The agent maximizes life time income by choosing the optimal amount of her bequest to invest in the H- and K-sector respectively as follows:

$$\max_{h_t} m_t = q \left[(1-\tau_t^*) b_{t-1}^i - h_t \right] + A_t \left(e^j \right)^{1-\beta} (h_t)^\beta \left[(\tau_t^* - f(\tau_t^*)) b_{t-1} \right]^{1-\beta} \tag{6}$$

where b_{t-1} indicates average bequests. Solving the first order conditions yields that

$$h_t^* = e^j b_{t-1} \left(\frac{\beta A_t}{q} \right)^{\frac{1}{1-\beta}} \left[\tau_t^* - f(\tau_t^*) \right] \tag{7}$$

$$k_t^* = (1-\tau_t^*) b_{t-1}^i - e^j b_{t-1} \left(\frac{\beta A_t}{q} \right)^{\frac{1}{1-\beta}} \left[\tau_t^* - f(\tau_t^*) \right] \tag{8}$$

as long as $h_t^* < (1-\tau_t^*) b_{t-1}^i$. In some cases agents become liquidity constrained, in the sense that they can not invest as much as they would like in the H-sector. This occurs when the return to investments in the H-sector is so large that agents want to invest more than they receive in bequest. Then $h_t^* = (1-\tau_t^*) b_{t-1}^i$ and $k_t^* = 0$.

3.2 Taxing Bequests

The optimal tax rate for an individual, not facing a binding liquidity constraint, is obtained through solving the following maximization with the restriction of balanced state budget:

$$\max_{\tau_t} v(\cdot) = \gamma^\gamma (1-\gamma)^{1-\gamma} \left\{ q (1-\tau_t) b_{t-1}^i + \kappa e^j b_{t-1} A_t^{\frac{1}{1-\beta}} (\tau_t - f(\tau_t)) \right\} ,$$

where

$$\kappa = (1-\beta) \left(\frac{\beta}{q} \right)^{\frac{\beta}{1-\beta}} .$$

The first order condition is:

$$\frac{\partial v(\cdot)}{\partial \tau_t} = -q b_{t-1}^i + \kappa e^j b_{t-1} A_t^{\frac{1}{1-\beta}} (1 - f') = 0 ,$$

where

$$f' = 1 - \frac{qb_{t-1}^{i}}{\kappa e^{j} b_{t-1} A_{t}^{\frac{1}{1-\beta}}} \ . \tag{9}$$

Let $f(\tau_t) = \tau_t^2$. Then, solving for τ_t and plugging in the expression for κ, leads to the following expression for the tax rate:

$$\tau_t = \frac{1}{2}\left(1 - \frac{q^{\frac{1}{1-\beta}}}{e^{j} A_{t}^{\frac{1}{1-\beta}} (1-\beta)\, \beta^{\frac{\beta}{1-\beta}}} \frac{b_{t-1}^{i}}{b_{t-1}}\right) \ . \tag{10}$$

The actual tax rate is:

$$\tau_t^{*} = \max\{0, \tau_t\} \quad .$$

The desired tax rate is positively related to the agent's skill level, $\frac{\partial \tau_t^{*}}{\partial e^{j}} > 0$, and negatively related to her wealth level in relation to average wealth $\frac{b_{t-1}^{i}}{b_{t-1}}$, since $\frac{\partial \tau_t^{*}}{\partial\left(\frac{b_{t-1}^{i}}{b_{t-1}}\right)} < 0$. If agents are liquidity constrained, then the optimal tax rate changes. Repeating the same calculations as above, but with $h_g^{*} = (1 - \tau_t^{*})\, b_{t-1}^{i}$, gives a preferred tax rate

$$\tau_t = \frac{1-\beta}{2-\beta} \quad . \tag{11}$$

The net gain from an additional tax unit is constant for a liquidity constrained agent. Since she no longer faces a trade-off between different forms of investment, her utility is linear with respect to the amount of bequest received. The gain from increased public production exactly balances the loss of paying taxes for each unit of tax payments.

3.3 The Median Voter Theorem

Sufficient conditions for applying the median voter theorem to the issue of choosing an optimal tax rate are that the issue is one-dimensional and that preferences are single-peaked over the tax rate. In the context of this paper, the theorem can be applied without restrictions.

3.4 Growth Mechanism

What determines the growth rate of an economy in this model? The rate of return to investments in the H-sector in relation to that in the K-sector is crucial in determining

economic development. The higher the return to investments in human capital for the decisive voter, the faster production is converted from the K-sector to the H-sector. The incentives to invest in human capital can be captured by analyzing the situations in which the median voter chooses a positive tax rate. From the production function of the H-sector follows that when $\tau_t^* = 0$ there will be no investments in human capital since the return to those is zero. Equation (10) implies that the following condition must hold for the median voter in order for growth to take place:

$$s^j > \frac{q^{\frac{1}{1-\beta}}}{A_t^{\frac{1}{1-\beta}} (1-\beta) \beta^{\frac{\beta}{1-\beta}}} \frac{b_{t-1}^i}{b_{t-1}} - w_0 \ . \tag{12}$$

Ceteris paribus, this means that if the median voter is rich, then in order to achieve growth her skill level has to be higher than if she would have been poor. Moreover, the higher the initial average education level in an economy, the less skill is needed to achieve growth.

This trade-off between the median voter's skill and relative wealth is one of the central insights in this paper. It hinges on the fact that the gain to an agent from higher taxes is dependent solely on average bequest of the population and her own skill level. Consequently, a high-skilled individual has the largest net gain from public production if she is initially poor.

4 Simulation

In principle the model is recursive and admits analytical solutions, but these are too complex to be revealing. In this section the model developed above is therefore simulated in order to analyze the pattern of industrialization in economies with different political systems and different skill distributions.

Since a generation normally is interpreted as being 25-30 years and it is likely that an economy is hit by a major shock at least once every century, the most interesting time horizon for an empirical analysis ought to be around 4 periods. Longer periods are of interest only if you like to analyze the hypothetical long-run implications in an unchanged environment.

4.1 Calibration of the model

The model is calibrated to capture the economic and social conditions prevailing during the first decades of the 19th century. Two initial wealth distributions are used. Both have the same initial aggregate wealth level as well as the same share of wealthy agents in the population, namely 10 per cent, but the shapes of the wealth distributions differ. In the so called unequal wealth distribution the rich have 60 per cent of total wealth, while in the case of a flat distribution they have 30 per cent of total wealth.[6] (Notice that within this model wealth and income have a fixed relation since bequests are derived as a constant share of income.) I let the rich be composed entirely either of high-skilled individuals, as in Plato's ideal world, or of low-skilled agents. The latter could be the case in a feudal society, where power is hereditary. Furthermore, I assume that the average competence level is the same across countries by letting half of the population in each country have s^{high} respectively s^{low}. Table 1 illustrates the composition of the population when the rich is constituted only by high-skilled agents.[7]

[6] The figures for England and Denmark at the beginning of the 19th century have served as indicators in the calibration of skewed (England) and flat (Denmark) income distributions. In Lindert (1986) estimates for England are available showing that the richest 10 per cent of the population possessed as much as 50 per cent of pretax income in 1803 and 60 percent of nonhuman wealth. Data for Denmark in Kraus (1987) for 1870 indicate that the income share of the top10 per cent of the population was 36 per cent. In order to get as clear-cut results as possible the model is simulated with the top10 per cent of the population having 60 and 30 per cent of total wealth. Regarding the size of the elite, it is the result of a compromise, since the elite plays both a political and economic role in the model. On the one hand, few countries had an electorate that exceeded 10 per cent of the population before 1850. (See Flora et al (1987) and Nohlen (1978) for country specific figures on franchise in the nineteenth century.) On the other, when dividing a population into rich and poor one would want to assign at least 20 per cent of the population to the rich.

[7] This assumption guarantees the comparability of different skill settings, for a given w_0. However, with this assumption the decisive voter can result to be just in between the high-skilled and the low-skilled group in democracies. There are two cases. Let the elite be low-skilled. Then in a democracy the decisive voter always will belong to the high-skilled group. Let now the elite be high-skilled. Since the groups are exactly the same size the median voter is just in between the high-skilled poor and the low-skilled poor. It has therefore been assumed that the decisive voter belongs to the low-skilled poor group, that also is the largest group in the population. The results generated with this additional assumption go through

Hence, there are three dimensions with two possibilities each, so allowing for all combinations of economic, political and skill dimensions means that we have eight economies with different growth-characteristics, that from now on will be referred to as countries.

	High-skilled	*Low-skilled*
Rich	0.1	0
Poor	0.4	0.5

Table 1: Population structure when the rich is high-skilled

The values of the consumption share, γ, and of the share of capital income, β, are chosen according to what is considered standard in the economic literature.[8] Moreover, although the population is normalized to one in the model, when simulating it is easier to have a larger population size. Table 2 presents these chosen parameter values.

n	γ	β
100	0.8	0.3

Table 2: Basic parameter values

As argued in section 3.3 the value of s^j is important for the subsequent development and must therefore be chosen with care. Assume that $s^{high} = 2s^{low}$, i.e. an s^{high}-agent is twice as competent as a s^{low}-agent. Furthermore, let $w_0 = 5$.[9] Table 3 presents these minimum values of s^{low} that are necessary for growth to occur for both shapes of initial wealth distributions. Clearly these parameter values have no straightforward interpretation, but they at least give an indication on the relative skill levels needed to initialize growth. When s^{low} is less than 7 no country will experience growth, while all countries will develop a human-capital intensive sector if s^{low} exceeds 139.

The skill space can therefore be divided into three regions as illustrated in Figure 1. In the first region, which is equivalent to s^{low} being less than 7, the implemented tax rate

for all cases when the low-skilled group is larger than the high-skilled. Since this is the likely direction of correction the additional assumption does not constitute a problem.

[8] See for example Perotti (1993) and Krusell and Ríos-Rull (1997).

[9] A low level of w_0 has been chosen for two reasons: to emphasize the role of the economic elite and to calibrate the model for the conditions prevalent during the nineteenth century.

	b_0^R	b_0^P
Flat wealth distribution		
high-skilled median voter	34	7
low-skilled median voter	67	14
Skewed wealth distribution		
high-skilled median voter	70	3
low-skilled median voter	139	6

Table 3: Lowest bounds of competence

will always be zero, implying an aggregate production level of Y_0 forever. In the middle region of the skill space, country after country start to develop. And when $s^{low} > 139$ the gains from investing in the human capital intensive sector are so large that all economies, regardless of wealth distribution, in this region will experience growth.[10]

Three set-ups of competence and initial average skill will be analyzed in detail in the next section. As a benchmark case we set $s^{low} = 40$ and $w_0 = 5$. In terms of the skill space this case belongs to the first part of the region with increasing growth potential, implying that some but not all countries considered will become industrialized. In the benchmark

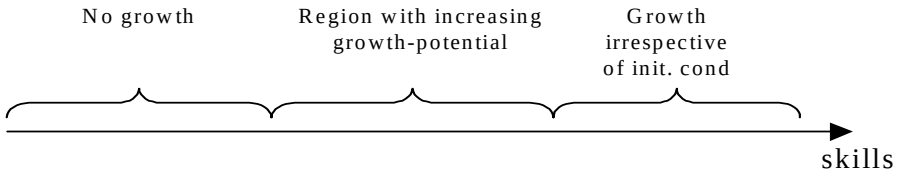

Figure 1: Skill space

case the mechanisms driving the results will be studied in detail. In the remaining two cases s^{low} and w_0 will be varied independently of each other in order to be in the later

[10]The reason for not analyzing the case when all countries get industrialized is that it requires an extremely high level of skills, which implies an explosive development. The switch from an agrarian economy to an industrialized one occurs almost entirely during one generation for all countries with that set-up.

region were all countries except for one is industrialized.

4.2 Benchmark

In the benchmark case the low competence-level and the initial average skill level have been chosen in order to be in the region of increasing growth-potential in the competence space. In other words, there are countries that will not experience development because of unfavorable initial characteristics. It turns out that no authoritarian regime, except the one with a flat initial wealth distribution and wealthy high-skilled agents, experiences growth. This can be seen in Figure 2. The reason for the lack of development is that the decisive voter does not gain enough from investments in the H-sector to vote for a positive tax rate.

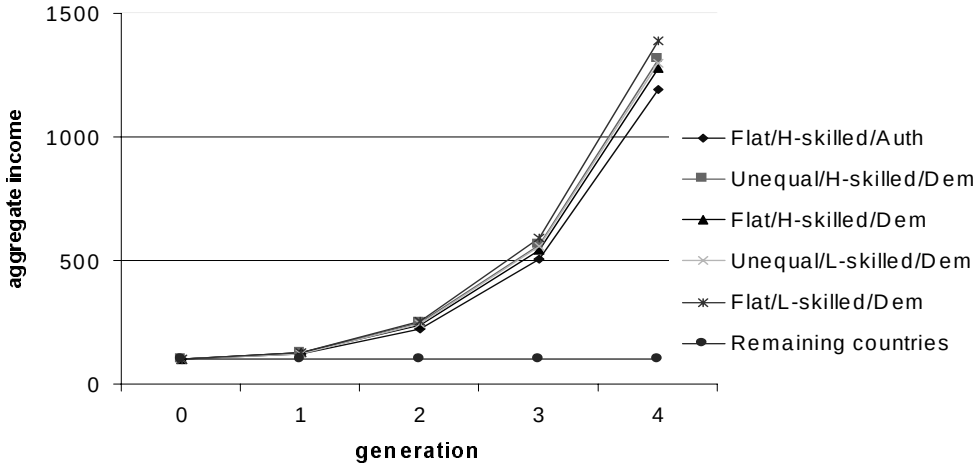

Figure 2: Aggregate income in the benchmark case

The authoritarian regime that has a positive development does comparatively worse than the democratic regimes. This depends on the relatively low tax rate implemented in the first periods, before democratization has occurred. (Detailed tables with tax rates and other figures of the simulations are to be found in Appendix A.) Figure 3 shows the democratization process, where the assumed positive relation between growth and democracy is evident: the country extending franchise is the only one experiencing growth.

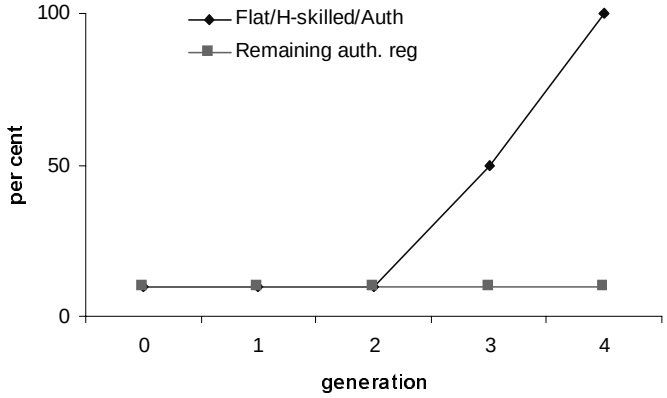

Figure 3: Size of the electorate as a share of total population

As can be seen in Table 4, a democratic regime that performs well in the first period, such as the regime with wealthy high-skilled agents and a flat initial wealth distribution, lags in the long run behind for example a democracy with wealthy low-skilled individuals and initially skewed wealth distribution.

	$t=1$	$t=4$	$t=10$
Unequal/H-skilled	3	2	2
Flat/H-skilled	1	4	4
Unequal/L-skilled	4	3	3
Flat/L-skilled	2	1	1

Table 4: Ranking of democracies w r t growth performance

What are the reasons for this? The factors influencing the outcome are the attributes of the median voter and those of the initially rich. The median voter in the former economy is low-skilled and poor and votes for a moderate tax rate, that does not itself give large incentives to invest in the human capital-intensive sector.[11] What makes this

[11] Her vote is the result of two countervailing forces. On the one hand, the low wealth level of the median

economy successful at the start is rather that the rich are high-skilled and hence that the aggregate amount of growth-promoting investments in the H-sector is relatively large during the first periods.

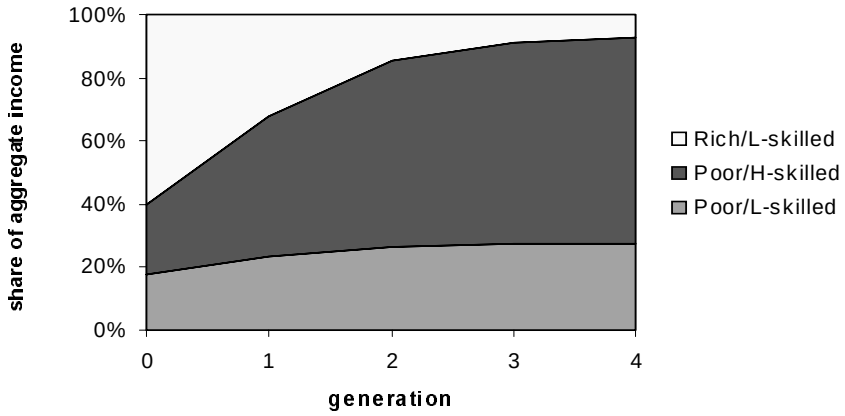

Figure 4: Income share of social groups

As opposed to this, the other democracy has a median voter who is both high-skilled and poor. Since the rich in this case are low-skilled, a period or two is required before the aggregate investment level in the H-sector becomes elevated.

The economic transformation of the agrarian economies into industrialized countries has consequences for the income distribution. Typically the rich in a developed economy are high-skilled agents. Take the example of a democracy that in period 0 has wealthy low-skilled individuals and a skewed income distribution; industrialization here implies that the originally rich become relatively less wealthy, while the high-skilled agents that initially were poor gain in terms of their share of aggregate income – see Figure 4.

The pattern of industrialization is illustrated in Figure 5, where the gradual pace of the process is evident. It takes three periods for most countries before they have shifted all production from one sector to another.

The conclusion from the analysis of the benchmark is that - from a development perspective - it is best to live in an initially democratic regime. Only in the case when

voter renders the tax burden of increased public service for the agent herself relatively small. On the other, she has small incentives to invest in the human capital-intensive sector, being herself low-skilled.

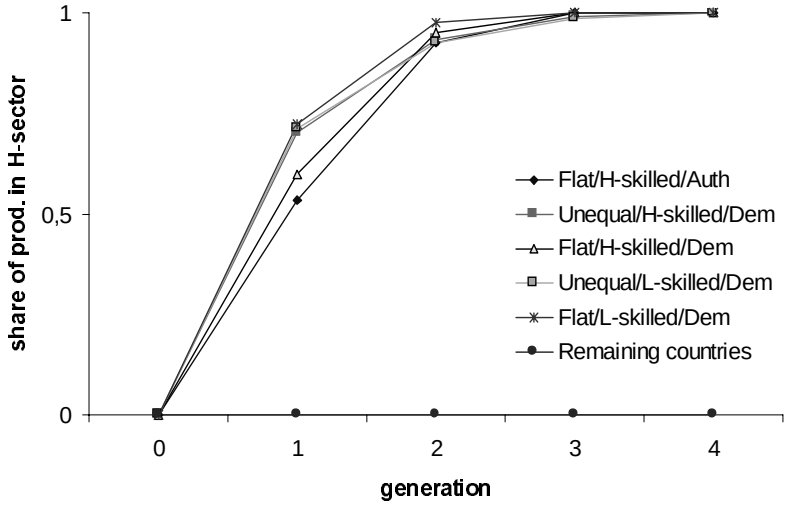

Figure 5: Share of total production in the H-sector

the authoritarian elite is relatively poor and high-skilled does it optimally choose a tax rate such that investments in the growth-enhancing H-sector are made.

4.3 Varying skills

In this section we are going to analyze the outcome of simulating the model when the skill level is so high that every country, except for one, becomes industrialized. The necessary requirements for this to happen is that e^{high} is not less than 145, according to equation (12). With respect to the benchmark we therefore have to increase either the competence level, s^{low}, or the initial average education level. The following cases: (a) $s^{low} = 70$ and $w_0 = 5$; and (b) $s^{low} = 40$ and $w_0 = 65$ are going to be studied while maintaining the assumption that $s^{high} = 2s^{low}$. In (a) therefore $e^{high} = 145$ and $e^{low} = 75$, while in (b) $e^{high} = 145$ and $e^{low} = 105$. Since the average skill level is higher in (b) than in (a), the return from investments in the human capital-intensive sector is larger in (a).

Simulating the model for the two sets of parameters gives the result that the economic transformation is more rapid with a higher average skill level, i.e. democratization occurs earlier and the aggregate income level is higher in (b), as illustrated in Figure 6. Hence, basic schooling appears to be more important than specific competence at initial phases

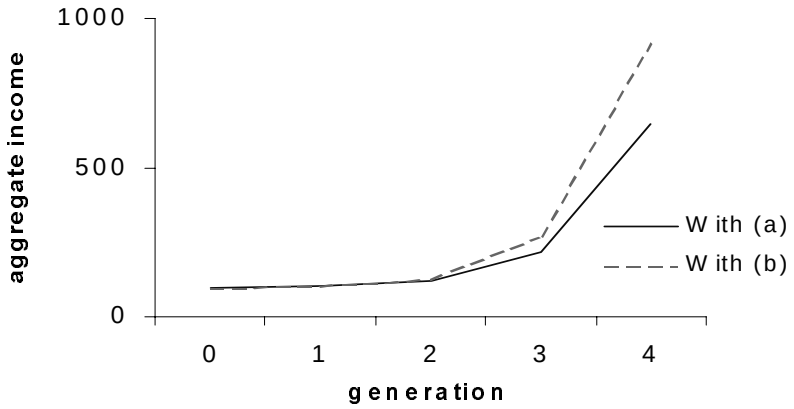

Figure 6: Aggregate income in authoritarian regimes

of industrialization processes.

Like in the benchmark case, the authoritarian regime that performs best is the one with an initially flat wealth distribution and wealthy high-skilled agents with both parameter set-ups. On average democracies still industrializes to a greater extent, and the country that does not develop at all has an authoritarian regime. A new feature that appears when varying skills is that authoritarian countries with flat wealth distributions are democratized earlier than those with initially skewed wealth distributions since the absolute gap in terms of bequests, that has to be bridged by a poor agent, is smaller.

4.4 Discussion of the Results

The simulations generate two broad conclusions. First, no setup of initial characteristics maximizes a country's development in all situations. Table 5 presents the ranking of the countries with respect to the level of aggregate income they achieve after four periods. In the column indicated as "Minimum" the countries are ranked according to the minimum level of competence they need to start the industrialization process. These results are derived from Table 3.[12] It can be noticed that an initially democratic regime with wealthy low-skilled agents and an initially skewed wealth distribution requires the least amount of competence from the median voter to start industrializing -indicated with 1. Countries

[12]Notice that these figures are valid under the assumption that franchise is not extended.

that initially have a democratic regime possess in this sense more growth-potential than those with an authoritarian regime.

	Minimum	Bench	Competence	Av. Education
Auth / H-skilled / skewed wealth distr	7	6	7	7
Auth / H-skilled / flat wealth distr	5	5	3	3
Auth / L-skilled / skewed wealth distr	8	6	8	8
Auth / L-skilled / flat wealth distr	6	6	6	4
Dem / H-skilled / skewed wealth distr	2	2	4	5
Dem / H-skilled / flat wealth distr	4	4	2	1
Dem / L-skilled / skewed wealth distr	1	1	5	6
Dem / L-skilled / flat wealth distr	3	3	1	2

Table 5: Ranking of economies with different assumptions

The three last columns in Table 5 indicate the ranking in terms of growth in respectively the benchmark and in the two cases when skills are varied as described in section 4.3. Comparing the columns it is evident that the ranking between countries shift according to the mix of initial institutional characteristics.

The second broad conclusion is that the time horizon matters when judging which institutional framework has most growth potential. The country that performs best in the long run is not always the one with the highest level of aggregate income in the first period, as shown in Table 4. This depends on the tension between what characteristics are positive for short respectively long run growth. A flat wealth distribution can initially cause high aggregate income since all agents invest relatively much. But at the same time a flat income distribution often implies that the tax rate is too low. Hence after one or a few periods the economy with a flat wealth distribution may have a lower aggregate income than a country with an initially skewed wealth distribution, that succeeds in raising more tax revenues.

Although these broad conclusions point to the impossibility of drawing general implications about the optimal institutional setup, there are some results regarding growth that are robust to variations in the parameter values.

Overall, initially democratic regimes require lower levels of skills to industrialize, since in these economies the median voter is poor and hence implements a high tax rate which, from an aggregate income-maximizing perspective, is desirable in this paper. Therefore, on the one hand, when the skill level is relatively low only democratic regimes develop economically. On the other, when skills are so high that all countries independently of initial characteristics are industrialized then the initially democratic regimes on average have a more favorable development.

Regarding authoritarian regimes it is possible to indicate which characteristics are most important for industrialization, since the ranking of countries with authoritarian regimes is namely always the same. The authoritarian regime that performs best, i.e. achieves the highest aggregate income, has an initially flat wealth distribution and wealthy high-skilled individuals. Moreover, the regime that is the last to become industrialized under all initial conditions is the authoritarian regime with wealthy low-skilled agents and an initially skewed wealth distribution. Studying Table 5 it appears that first of all it is important to have an initially flat wealth distribution, and secondly to have high-skilled wealthy individuals.

4.5 Robustness of the results

The robustness of the results is tested by varying the parameters in the model. The size of the rich group is intuitively important for the outcome, so we start by varying this parameter keeping initial average income constant. Simulations have been run with the rich constituting 1, 5 and 20 per cent of the population, while possessing 60 and 30 per cent of aggregate wealth respectively. The speed of the transition process is higher the larger the share of the population being rich. Furthermore, the larger the number of wealthy agents in a country, the more countries become industrialized. What are the reasons for these results? What changes between these cases and the benchmark is the decisive voter's bequest in relation to average bequest. In authoritarian regimes a smaller group of rich agents than in the benchmark case hinder growth, while growth is enhanced with a larger group of rich agents. In countries that are initially democratic the change in the number of wealthy agents only has level-effects: the aggregate income and the share

of total production in the H-sector are higher. The reason is that the variation of the in the composition of the population does not alter the characteristics of the median voter. The main results hold when varying the number of wealthy agents in the population, i.e. there is no set-up of initial characteristics that maximizes development in all situations and the time horizon does still matter. Also the minor results hold: the authoritarian regime that promotes growth the most is still the one with a flat wealth distribution and wealthy high-skilled individuals; democracies still have most growth potential; and the internal ranking of democracies shifts, as before, with respect to the parameter values used in the simulations.

As can be seen in equation (12) the level of q does not affect the growth potential of a country. However, a level of q less than $\frac{1}{1-\gamma}$ makes investments in the H-sector even more profitable. In countries that become industrialized this implies that the speed of transformation is relatively higher, while for the countries that remain agrarian economies there is a gradual decrease of incomes. The opposite happens when $q > \frac{1}{1-\gamma}$. Varying the share of capital income affects the growth potential of economies directly. For example in the benchmark case no authoritarian regimes would become industrialized if $\beta = 0.4$, and in democracies the transition process would be prolonged. If the share of capital income is decreased to 0.2, then industrializing is more profitable for all agents. Given a certain shape of the wealth distribution, the growth rate of an economy is independent of the initial level of aggregate income, M_0. This has significant empirical implications. It indicates that initial differences in the level of per capita wealth have permanent consequences in that there is no catching up if countries have the same initial characteristics but different income per capita levels.

The overall conclusion from the robustness test is hence that the qualitative results go through when the parameter values are changed.

5 Empirical Evidence

5.1 Taking the Model to the Data

The aim of the empirical section is to study whether the outcomes of the model are consistent with data. Although the model also generates other hypotheses, interest is focused on whether the simulated technological transition of countries corresponds to the actual development. For example, does the United States belong to the group of countries that are first to become industrialized according to the model?

To be able to confront the model with data some variables have to be constructed. Criteria for determining the type of regime in a country must be decided on. I choose to do that in accordance with the discrete structure of the model. For example, a country is either said to be authoritarian or democratic, while the initial income distribution is either flat or skewed. Since the model hinges on the existence of a large shock, both the start and the end point of the historical data series have to be selected with care. I have chosen to study the development of 23 economies during the so called first industrial revolution. What are the motives for choosing this historical period?

Technological progress accomplished during the first industrial revolution can be considered an example of a major exogenous shock that permanently altered the incentives to invest in the human capital-intensive sector. As argued in Rosenberg and Birdzell (1986), this revolution was the result of centuries of changes at the economic, political, technological and institutional level. It is therefore simplistic to claim that this revolution occurred at a specific point in time. However, what I am interested in is when these changes altered the incentives of the masses. I propose mainly for two reasons the first few decades of the 19th century – say 1820 to have a fixed date to refer to – as the time when the external shock occurred . First, the Napoleonic wars were ending and many of the technical innovations necessary for a large-scale industrialization had been made.[13]

[13] See chapter 5 in Rosenberg and Birdzell (1986) for information about the innovations. Furthermore, Kenwood and Loughed (1992) state that "the available evidence for the 19th century suggests that the diffusion of modern industrial technology between countries was much faster than its diffusion within countries". This hints to the fact that the major obstacles to industrialization were nation-specific, and not caused by the lack of technical knowledge.

Second, from a practical viewpoint, data is almost non-existent for previous periods, apart from a handful of European countries.[14] Clearly data remains a problem from 1820 and forward too, but for most of the variables required at least proxies are given in Adelman and Taft Morris (1988) or in Maddison (1995). It seems reasonable to let the sample end with the beginning of World War I, which, like the industrial revolution, must be considered a large shock that profoundly affected economic conditions. This means that I have a time period of hundred years, roughly corresponding to four periods in the model.

5.2 Historical Data

The group of 23 countries studied (see Table 6 for a list) contains both European, American and Asian states and is therefore an interesting cross-section. How are these countries classified according to their characteristics? A brief description of the data used is presented below, while more detailed accounts of the series are to be found in Appendix B.

	Wealthy high-skilled agents	Wealthy low-skilled agents
Flat income distribution	Denmark, Netherlands, Switzerland, Belgium, Canada, France, Norway, Sweden, US, New Zealand,	Burma, China, India, Japan
Skewed income distribution	Great Britain, Australia	Germany, Spain, Argentina, Brazil, Egypt, Italy, Russia

Table 6: Classification of authoritarian regimes

To assert whether a country was democratic or not the extent of franchise in 1820 is used.[15] Since almost only men were allowed to vote and there often were income or property restrictions to voting until the twentieth century, universal male suffrage is used

[14] See Flora and Pfenning (1987).

[15] The problem of reverse causation has been avoided by measuring the extent of franchise at the beginning of the period of analysis. Regarding average schooling and inequality the same procedure has been applied.

as the indicator of a country's political regime. A country is considered to be a democracy when all men of eligible age have the right to vote. This was not the case for any of the countries in 1820 and hence no country is classified as being democratic at the beginning of the period.[16]

The skill distribution, as defined in this paper, reflects two features: average schooling in the population and the competence of an agent. To estimate whether the rich agents were initially high-skilled, an index of the "favorableness of attitudes toward entrepreneurship" in Adelman and Taft Morris (1988) has been used. According to the authors, "[we] group countries by the extent to which the established social elite had favorable attitudes towards entrepreneurial success – particularly entrepreneurial success with factory enterprise. [...] In classifying country observations, we do not judge whether attitudes towards entrepreneurship helped or hindered growth."[17] The underlying assumption is then that a favorable attitude towards entrepreneurship is typical of a high skilled-economic elite.

As an indicator of the average education in the population enrollment in primary education is employed. Since there are no data on enrollment rates for 1820 for any of the countries, an index over the spread of primary education from Adelman and Taft Morris (1987) is used instead.

The income level per capita is estimated by GDP per capita. But the initial income distribution is difficult to identify with certainty; quantitative information is scarce. Different sources therefore have to be employed in order to construct a classification. The starting point used is an index of "concentration in landholdings" for 1850 of Adelman and Taft Morris (1988), which is constructed in order to be "indicative of the distribution of agricultural surplus above subsistence".[18]

The considerations above lead to the classification of the countries in the sample with respect to skills, political regime and shape of initial income distribution presented in Table 6. Within each of the four groups the countries have been ranked with respect to

[16] Eight of the 23 countries, namely Argentina, Australia, Brazil, Burma, Canada, India, New Zealand and Norway were not independent countries in 1820. Italy and Germany did not exist as political entities. These countries are defined as authoritarian regimes given the lack of democratic influence.

[17] Adelman and Taft Morris (1988), p. 235.

[18] Adelman and Taft Morris (1988), p. 129.

their level of school enrollment. Denmark, Netherlands and Switzerland are for example the countries in the first group that have the highest school enrollment. In the following section the actual economic and political development of these 23 countries is compared with the outcomes of the simulations. What remains to be established is how to measure the extent to which a country became industrialized or less industrialized. Normally the growth of GDP per capita is used to grasp the economic development of nations. GDP per capita is however an adequate measure of the transition to an industrialized economy only if the change in per capita income is due to industrialization directly. If it for example is the result of increased trade in non-manufactured goods, it obviously no longer is a good measure. An index of output of manufactures per head of population in 1913, designed by A. Lewis (1978), is therefore used to capture to which extent nations had become industrialized along with the growth rate of GDP per capita.

5.3 Comparing the Model with Data

To what extent does the results of the simulations regarding the industrialization of authoritarian regimes match that of the real world? Figure 7 presents the ranking of countries with respect to their degree of industrialization in 1913 and the simulation results. The ideal way of proceeding when studying the outcome of the model would have been to simulate the model for each country in the sample and then rank them in terms of their growth performance. However, for that to be meaningful precise estimates of the initial industrialization level, the return to investments in each country, etc. would have been required. Given the lack of that kind of data, the countries in the right column in Table 7 are only ranked according to their group performance in the simulations.

According to the simulations countries in Group 1 should become industrialized first. Comparing the simulation results with data there are three outliers, namely Australia, Germany and Great Britain. Out of these three the case of Great Britain might be explainable in relation to its level of industrialization in 1820, while in the cases of Australia and Germany the outcome may depend on the classifications made. When simulating the model it is assumed that all countries had no industrial production in period 0. This clearly was not the case of Great Britain in 1820, leading to the conclusion that Great

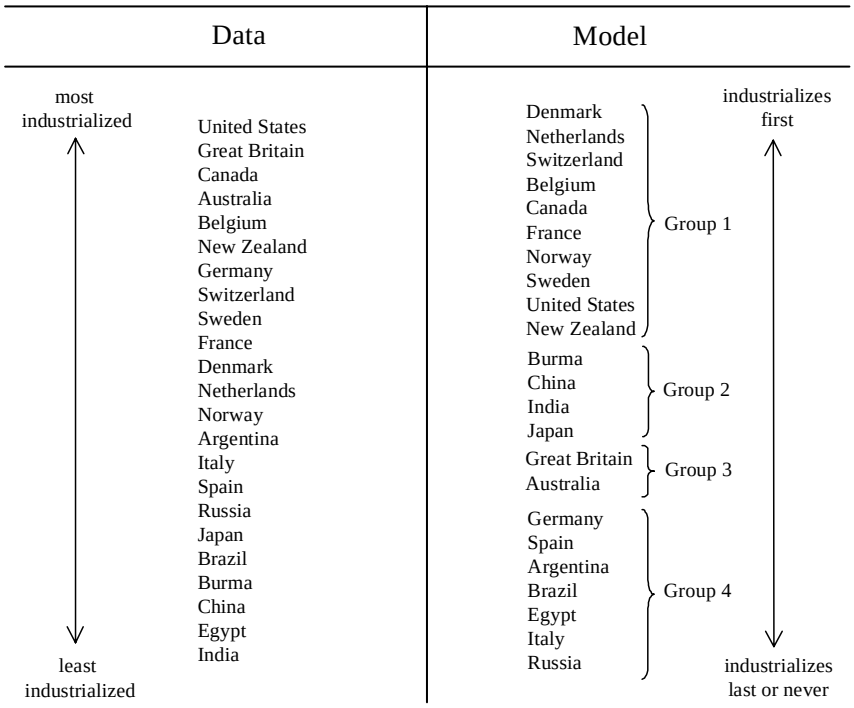

Figure 7: Industrialization in data and model, 1913

Britain maybe should be excluded from the sample. For the case of Australia it might well be that the income distribution was flat in 1820, as argued in Appendix B.3, and the country therefore should belong to the group with the highest predicted growth. It would also be possible to argue that Germany should be included in Group 3 since enrollment in primary school was relatively high.[19]

Having examined the ranking of countries in data and the model, it is interesting to further study the correlations between the main variables, first by inspecting cross-section plots and later by some regression analysis. Figure 8 contains plots of competence, inequality and primary school enrollment against both the average annual growth rate 1820-1913 and the industrialization index for 1913. The variables on the X-axis refer to the beginning of the period of analysis (1820). The model presumes that there is a positive relationship with the human capital variables and industrialization, while the income distribution should have an ambivalent effect on industrialization. It can be seen that there is a positive relationship between the competence of the rich 1820 and

[19] See Cameron (1993), p. 220, for more details on primary school enrollment rates.

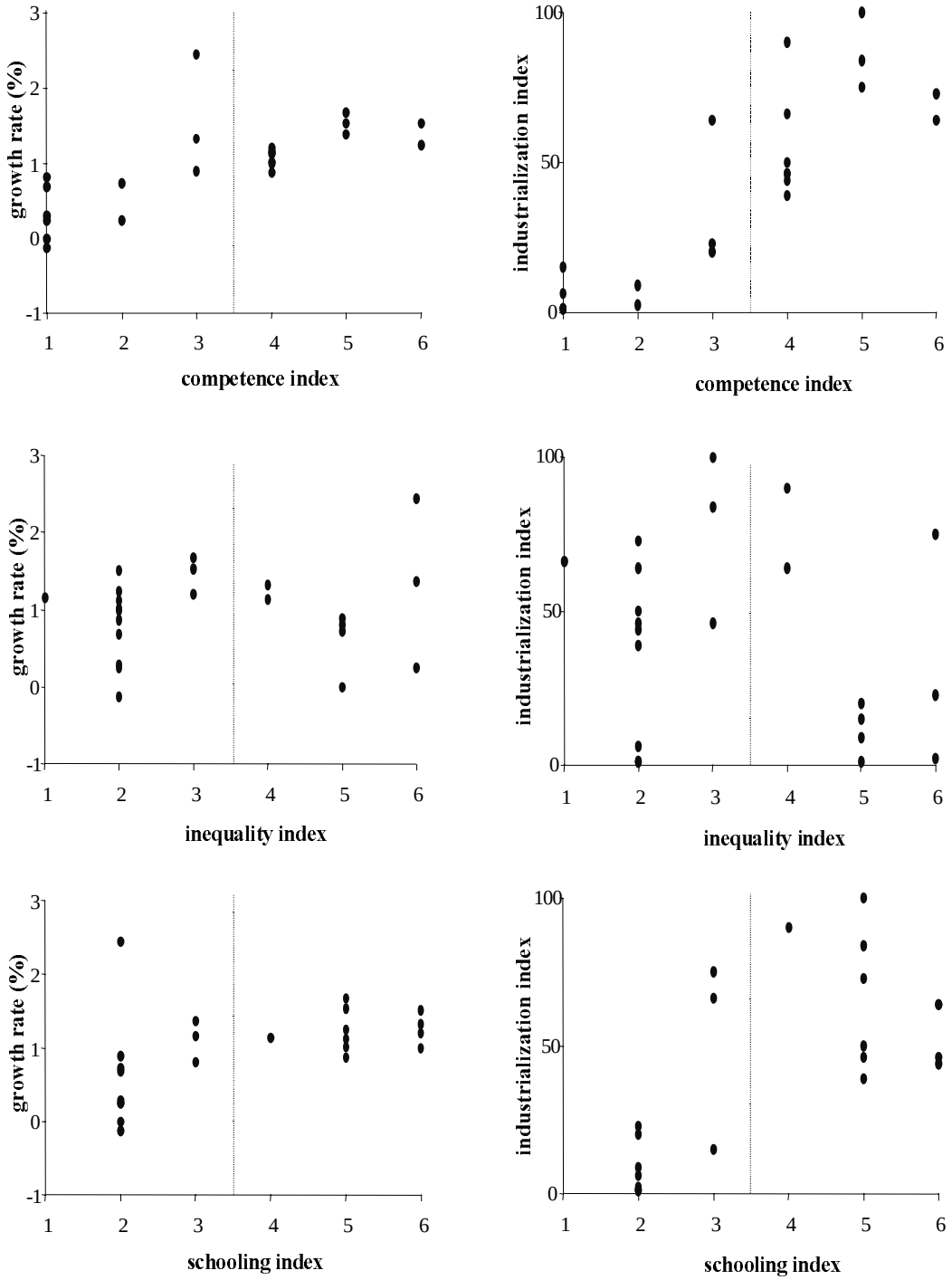

Figure 8: Plotting competence, inequality and schooling against growth and industrialization

the degree of industrialization in 1913, as well as between competence and the growth rate of GDP during this period. The former correlation is however stronger than the latter. The plots for the schooling index are analogous: the correlation of primary school enrollment is much more significantly correlated with industrialization than with growth. Inequality seems to be unrelated to both industrialization and the growth rate as can be seen in Figure 8. This might depend on the fact that the inequality index measures the concentration of landholdings instead of wealth dispersion.

These plots indicate the model seems to be more relevant in explaining the extent of industrialization a country achieves rather than the growth rate. This is reasonable since an increase in the per capita growth rate very well can be the result of for example the augment of exports of primary goods, which can occur independently of any technological transition.

The model in this paper also has implications for the political development of economies. More precisely if the country undergoes a technological transition, then franchise is expected to be extended. How does this concord with data? In order to control for the effects of extensions of suffrage it would be necessary to have data on the extent of political participation for the whole nineteenth century. But this kind of data only exists from (around) year 1900 and onward for most countries. However, an index over the "level of democracy" in Jaggers and Gurr (1995) measuring the level of institutional democracy and autocracy can be used in the analysis instead.[20] Figure 9 shows the political development according to this index for the four groups in the simulations. Groups 1 and 3 extend franchise as they become industrialized, while Group 2 and 4 barely experiences any political development since they do not experience a technological transition. The assumed positive relation between industrialization and extension of franchise hence appears to be supported by data.

Regressions on cross-section data have been performed with both an industrialization index and the annual average growth rate as dependent variables. The time periods considered are 1820-1913 and 1870-1913. The latter is of interest since data quality improves considerably at that time, especially for schooling. Not withstanding the problems with

[20] Exact dates of the extension of franchise in the 23 countries are presented in Appendix B.1.

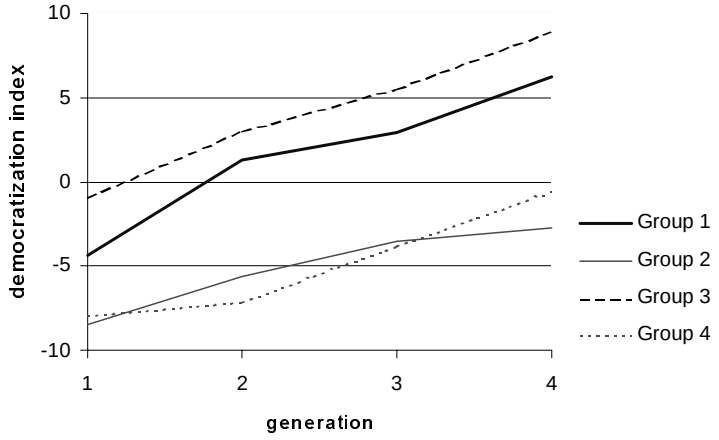

Figure 9: Democratization measured with Jagger and Gurr's index

biased estimators -due to the small sample, measurement problems, etc.- hopefully these regression still can shed light on the relative importance of the independent variables in explaining the industrialization pattern. Table 7 presents the regression results; t-values are given in brackets.

The independent variables used are the following: *competence* as defined in Appendix B.2; *school1* and *school2*, where the former is the Adelman and Taft Morris index for the spread of primary education 1830-50 and the latter the enrollment in primary schooling divided by population size measured around 1870 – both presented in Appendix B.4; *inequality* as defined in Appendix B.3; *GDPgap* is the gap in terms of aggregate income between the country in question and the one with highest income respectively in 1820 and 1870; *democracy* is a dummy variable where the countries having universal male suffrage in 1870 are classified as 1, and the rest as 0.

Regressions (1)-(4) are those to focus interest on, since they are run on data for the whole time period 1820-1913. In these regressions competence is always significantly positively correlated with both GDPgrowth and the industrialization index. The schooling index has no explanatory power in these columns, which probably is to be attributed to the inadequacy of the index used. The same regression have be run for the period 1870-1913 in order to control if a more precise estimate of school enrollment is significantly

	Growth(1820)		Industrializ.(1820)		Growth(1870)		Industrializ.(1870)	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Const.	-0.26	-0.23	-20.17	-22.52	0.33	0.28	-0.22	-20.24
	(-0.68)	(-0.57)	(-1.78)	(-1.88)	(0.77)	(0.65)	(-2.31)	(-2.21)
Competence	0.21	0.23	17.37	15.86	0.06	0.19	14.64	10.86
	(2.56)	(2.06)	(6.91)	(4.76)	(0.58)	(1.18)	(6.44)	(3.16)
School1	0.04	0.047	0.70	0.60				
	(0.49)	(0.49)	(0.25)	(0.21)				
School2					0.038	0.04	1.12	1.06
					(1.50)	(1.58)	(2.02)	(1.96)
Inequality	0.09	0.09	-1.08	-1.07	0.05	0.06	-0.30	-0.55
	(1.32)	(1.28)	(-0.55)	(-0.53)	(0.67)	(0.77)	(-0.17)	(-0.33)
GDPgap(1820)		-0.001		0.14				
		(-0.23)		(0.70)				
GDPgap(1870)						-0.01		0.29
						(-1.05)		(1.43)
Democracy					0.15	0.08	-0.24	1.78
					(0.43)	(0.22)	(-0.03)	(0.24)
$\overline{R}^2$	0.44	0.41	0.84	0.83	0.22	0.22	0.86	0.87

Table 7: Regression results

correlated with the growth rate and the industrialization index. Columns (5)-(8) contain these regressions, and clearly show that *school2* is significantly positively correlated with both the dependent variables, as predicted by the model.

We also notice that competence in regression (5) and (6) is not significantly correlated with growth. The reason why these two regression perform badly in general – $\overline{R}^2 < 25$ in both – is probably that several countries in the sample experienced a large increase in aggregate income due to other factors than industrialization. For example, the increase in exports of primary goods explains large part of Argentina's elevated growth rate at

the end of the 19th century. Figure 10 shows the correlation between competence and the level of industrialization when school enrollment and inequality are held constant, using regression (3). This figure confirms the importance of the skill level of the rich for industrialization.

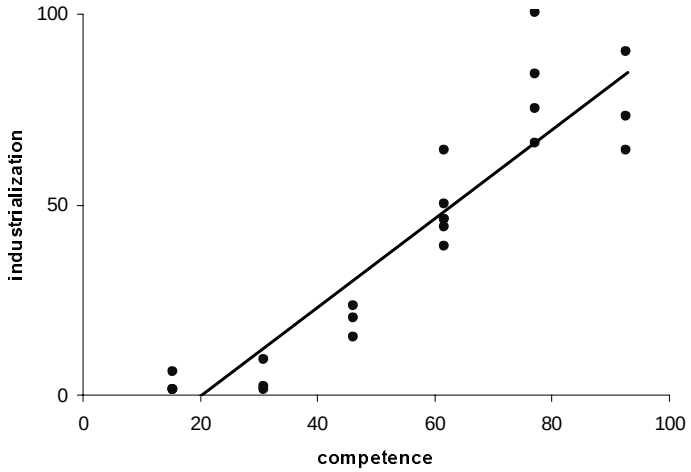

Figure 10: Partial correlation of competence and industrialization

6 Concluding Observations

The model in this paper has the distinguishing feature of studying the importance of social groups in a wide respect. It has been shown that the distribution of skills in the population determines the outcome of an industrialization, together with the political power of different groups and the initial wealth distribution. Out of 23 countries the economic development in 20 of them is broadly in line with the results of the simulations. The model thus seems at least weakly consistent with data.

Groups in society are however characterized by other aspects than their skill levels and initial wealth, for example by gender. Particularly if extending this model to Post-war technological transitions it would be of interest to include the gender aspect, given women's increasingly active role in the political and economic spheres of society. "Did the countries with a larger female labor participation experience a faster technological

transition?" would be one of the possible questions for future research in this direction.

It would be interesting to adapt this model to fit the Postwar period also in order to allow for two other extensions. The first extension would be to introduce the possibility to use tax revenues for pure redistribution, given that the role of the state is larger than ever before. Tax revenues could then either be used to produce public services that benefits the growth-promoting sector or go directly to transfers, as in Alesina and Rodrik (1994). In such a setting income differences would create a new redistributive conflict among social groups. The other extension would be to let the passage from an authoritarian regime to a democratic be a function of social unrest, much like in the paper by Acemoglu and Robinson (1998). They capture the democratization process by introducing social unrest that acts like a constraint on an authoritarian elite to either increase redistribution or democratize, making the democratization very short. This extension could capture the high speed with which authoritarian governments have turned democratic in the Post-war period. Combining the two extensions the intuitive result would be that redistributive conflicts increase the likelihood for a change of political regime from an authoritarian to a democratic one. Moreover, democratic regimes risk to get too little resources assigned to the growth-promoting sector, because much of the tax revenues would go to transfers.

These are only some of the possible extensions. The role of the skill distribution in technological transitions is likely to be much discussed in the future when studying the passage from industrial to post-industrial economies since it, as has been shown in this paper, is important for the development of the economy.

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A Simulation results

Detailed results from the simulations are reported below in separate tables for each of the cases examined. The variable values presented are: the level of aggregate income (M), the share of aggregate production in the H-sector ($\frac{Y^H}{Y}$), if the regime is democratic (*democracy*) and the implemented tax rate (τ^*). All the values refer to those assumed in period 4.

INITIAL AUTH. REGIMES	M_4	$\frac{Y_4^H}{Y_4}$	democracy$_4$	τ_4^*
Wealthy high-skilled agents:				
–flat wealth distr	1193	1	yes	0.41
–unequal wealth distr	100	0	no	0
Wealthy low-skilled agents:				
–flat wealth distr	100	0	no	0
–unequal wealth distr	100	0	no	0

Table 8: Authoritarian regimes in the benchmark case

INITIAL DEMOCRACIES	M_4	$\frac{Y_4^H}{Y_4^{TOT}}$	democracy$_4$	τ_4^*
Wealthy high-skilled agents:				
–flat wealth distr	1278	1	yes	0.41
–unequal wealth distr	1316	1	yes	0.41
Wealthy low-skilled agents:				
–flat wealth distr	1388	1	yes	0.41
–unequal wealth distr	1295	0.99	yes	0.41

Table 9: Democracies in the benchmark case

INITIAL AUTH. REGIMES	M_4	$\frac{Y_4^H}{Y_4^{TOT}}$	democracy$_4$	τ_4^*
Wealthy high-skilled agents:				
–flat wealth distr	6172	1	yes	0.41
–unequal wealth distr	684	0.98	no	0.39
Wealthy low-skilled agents:				
–flat wealth distr	4798	1	yes	0.41
–unequal wealth distr	100	0	no	0

Table 10: Authoritarian regimes in the high competence case

INITIAL DEMOCRACIES	M_4	$\frac{Y_4^H}{Y_4}$	democracy$_4$	τ_4^*
Wealthy high-skilled agents:				
–flat wealth distr	6259	1	yes	0.41
–unequal wealth distr	5766	1	yes	0.41
Wealthy low-skilled agents:				
–flat wealth distr	6313	1	yes	0.41
–unequal wealth distr	5580	1	yes	0.41

Table 11: Democracies in the high competence case

INITIAL AUTH. REGIMES	M_4	$\frac{Y_4^H}{Y_4}$	democracy$_4$	τ_4^*
Wealthy high-skilled agents:				
–flat wealth distr	8951	1	yes	0.41
–unequal wealth distr	909	1	no	0.41
Wealthy low-skilled agents:				
–flat wealth distr	8297	1	yes	0.41
–unequal wealth distr	100	0	no	0

Table 12: Authoritarian regimes in the high average schooling case

INITIAL DEMOCRACIES	M_4	$\frac{Y_4^H}{Y_4}$	democracy$_4$	τ_4^*
Wealthy high-skilled agents:				
–flat wealth distr	9236	1	yes	0.41
–unequal wealth distr	8243	1	yes	0.41
Wealthy low-skilled agents:				
–flat wealth distr	8091	1	yes	0.41
–unequal wealth distr	9219	1	yes	0.41

Table 13: Democracies in the high average schooling case

B Historical Classification of Countries

B.1 The Political Regime

Although universal franchise is the measure that should be used in general, the historical context makes male suffrage a more appropriate indicator. One type of restriction is however admitted when defining a country as democratic in the model, namely age requirements. It was customary during the 19th century to require an age of at least 25 years, but that is not considered to be a limitation of franchise. Table 14 presents the dates at which universal male suffrage was achieved, given that it occurred before 1914. The sources used to compile this table are Flora (1987), Lane (1984) and Nohlen (1978).

	Male suffrage		Male suffrage
Argentina	1910	Italy	1913
Australia	1901	New Zealand	1879
Belgium	1892	Norway	1897
Canada	1898	Spain	1890
Denmark	1849	Sweden	1909
France	1848	Switzerland	1848
Germany	1872	United States	1840

Table 14: Extension of suffrage

The index over the "level of democracy" in Jaggers and Gurr (1995) has been used to assure that the countries that were colonies in 1820 had an own political development, well-distinct from their motherland. Countries for which data is missing for the whole period are: Canada, Belgium, Switzerland, Burma, India, Australia, New Zealand. Countries for which data is missing before 1824 are Brazil and Argentina. The index has been calculated as suggested in Jaggers and Gurr (1995), i.e. subtracting the index of democracy score from the index of autocracy scores in the Polity III data set. The resulting index then ranges from -10 to 10, where 10 is purely democratic regimes.

B.2 The Skill Distribution

There are six categories in the classification scheme, reported as Table A41 in Adelman and Taft Morris (1988). They are presented below in the words of the authors; in parenthesis the economies belonging to each category in 1850 is reported.[21]

1. Countries where social recognition of capital entrepreneurial success by the established social elite was indicated by a combination of the following: official recognition of capitalist achievements by the crown; intermarriage between the established, usually landed, elite and the children of industrial entrepreneurs of non-elite background; and the retention of industrial entrepreneurs in industry rather than their early retirement to landownership. (Belgium, Switzerland)

2. Countries where there were two different cultures, one of which met the criteria for Category 1 and the other which met the criteria of Category (3). (Australia, Canada, United States)

3. Countries where social recognition of capitalist entrepreneurs, by those who inherited social position and wealth, went largely to the sons of those with inherited position and wealth and to a smaller number of non-elite capitalist entrepreneurs, who became extremely wealthy compared with those who were already part of the elite. Also included in this category are countries where the social elite recognized socially those with wealth accumulated in mercantile activities but had much less respect for those who accumulated wealth in industrial activities. (Denmark, France?, Great Britain?, Netherlands, New Zealand, Norway, Sweden?)

[21] The question mark after certain countries is reported as in the original text. The explanation they give is the following. "A question mark following a country assignment indicates that the information in the sources cited is insufficient to classify the country with great confidence. These assignments should be treated as "guessestimates". The absence of a question mark means that we are quite confident about ranking a country observation below observations having higher letter scores and above those having lower letter scores. Occasionally, no sources are cited for a case flagged with a question mark. In these instances we have used a wide range of uncited information to arrive at a guesstimate." (Adelman and Taft Morris (1986), pp. 241-242.)

4. Countries where elitist attitudes toward capitalist entrepreneurship in one major region met the criteria for Category (3), while elitist attitudes in another major region met the criteria for Category (5). (Argentina, Germany, Italy)

5. Countries where social recognition of newly successful entrepreneurs was granted to only a small number who were extremely successful in primary-export production and in the process became very large landowners. Even here recognition was more often given by the government than by the established landed elite. In these countries large accumulations of mercantile wealth were not regarded by the established social elite as a basis for social acceptance. (Brazil, Russia)

6. Countries were social recognition of capitalist entrepreneurship by the established social elite was not common. (Burma?, China, Egypt, India, Japan, Spain)

Countries belonging to the three first categories are considered to have high-skilled wealthy agents in 1820.

B.3 Initial Inequality

The starting point for finding a classification of initial wealth inequality is the index of concentration of landholdings in Adelman and Taft Morris (1988). There are seven categories in this index as reported in their table A38 (in parenthesis the economies belonging to each category in 1850 are reported):

1. Countries with an extreme concentration of landholdings with the top 10 percent of landholders holding at least 75 percent of the cultivated land. Excluded are countries where the overwhelming proportion of landholders were peasants with very small holdings using no year-round hired labor. (Argentina?, Australia?, Brazil?)

2. Countries with an extreme concentration of landholdings, but not necessarily meeting the criterion that the top 10 percent hold at least 75 percent of the cultivated land, where, judging by available numbers, peasants having very small holdings and using no year-round hired labor where overwhelmingly predominant. (Egypt, Italy, Russia. Spain)

3. Countries where the predominant scale of holdings was large, but where the concentration of landholdings was considerably less than in countries of Categories (1) and (2). "Large" means that hired labor undertook the greater part of cultivation. Countries where a significant part of the cultivated land was characterized by small holdings using little or no permanent hired labor as classified (3-). (Germany(-), Great Britain)

4. Countries where the greater part of the cultivated land was exploited on middle-sized holdings using permanent hired labor. (Canada?, Denmark, United States)

5. Countries where the greater part of the cultivated land was exploited on small holdings using little permanent hired labor. excluded are countries meeting this criterion where parcelization and fragmentation of holdings were widespread. (Burma, France, India?, Japan, Netherlands, Sweden, Switzerland)

6. Countries where the greater part of the cultivated land was exploited on very small holdings, with parcelization of holdings and fragmentation of holdings widespread. (Belgium, China, Norway)

7. Countries were identifiable individual holdings were uncommon because of the prevalence of communal agriculture. (New Zealand)

Countries belonging to the categories (1)-(3) are defined as having an skewed wealth distribution, while the rest are classified as having a flat distribution. The question is now how this subdivision stands when confronted with other data on inequality. Is it correct to classify Germany as having an unequal distribution while Denmark's flat? According to Lindert (1986), "the wealth shares of the top 1 percent, 5 percent, and 10 percent for England and Wales in 1810 or 1875 exceeded those for Denmark in 1789, Sweden in 1800, Finland in 1800, Prussia in 1908, or the United States at any of four prewar dates (1798, 1850, 1860, and 1870)." Using "wealth shares" as an indicator of the wealth distribution supports the classification made.

In general, proper data on the shape of the wealth (and income) distribution for more than a few countries is available first after World War I. See for example Kraus (1987)

and Flora et al (1987). Since the shape of the wealth distribution in this model is directly derived from the income distribution, I will consider also data on income distributions in the attempt of determining the shape of wealth distributions in 1820.

Now, there is a gap of twenty-thirty years that has to be bridged in order for the Adelman and Taft Morris index to be usable. The risk when using this classification for 1820 varies with respect to a country's production structure. In agrarian economies the concentration of landholdings does not change considerably over time, therefore the figures for these countries in 1850 ought to be good indicators of their situation in 1820. One possible exception to this reasoning would be Australia. There is evidence that the situation changed considerably during the first half of the nineteenth century. As asserted in Thomas (1991) "we can treat Australia in 1788 as a tabula rasa as far as inequality is concerned", but this changed rapidly and in 1840 the concentration of landholdings was high. Therefore, the figure for 1850 may not be relevant when classifying Australia in 1820.

The countries that underwent some industrialization during the years 1820-1850 must be considered as a separate case. The difficulty lies in those economies that started industrializing during the first half of the century, namely Great Britain, the United States, Belgium, France and Germany, where changes in inequality can have occurred. Great Britain does not constitute a problem since we know from the passage quoted above in Lindert that it was more unequal than Denmark, etc. in 1800. But for the remaining countries it is not possible to state with certainty that there have not been any major changes in the shape of the income distribution during that period, influencing the wealth distribution. If one believes in the Kuznets-hypothesis then it is possible to argue that if there were any changes, the income distribution grew more unequal during the period 1820-1850, as the countries were at the initial phase of their industrialization process. Given that these early industrializers classified as having a relatively flat income distribution in 1850, one could consider the question resolved. The classification of Adelman and Taft Morris will be used without any alterations.

B.4 Spread of Primary Education

There are two type of sources regarding the spread of primary education. Adelman and Taft Morris (1987) that presents an index of the spread of primary education. Flora et al (1987), Institut de Statistique International (1892), Mitchell (1981), Mitchell (1983), and Mitchell (1995) report the number of enrolled in primary education, sometimes in per capita terms. It is only possible to find aggregate data for primary and secondary enrollment for Canada and Australia during the period considered. (Since enrollment in secondary education in general was negligible during the nineteenth century, the aggregate figures are used without modifications.) The only country for which no estimates at all of the spread of primary education has been found is China. Table 15 presents for each country the first year for which data exist.

Argentina	1882	France	1837	Norway	1837
Australia	1840	Germany	1861	Russia	1872
Belgium	1830	Great Britain	1850	Spain	1855
Brazil	1871	India	1877	Sweden	1865
Burma	1877	Italy	1861	Switzerland	1871
Canada	1868	Japan	1873	United States	1871
Denmark	1893	Netherlands	1851		
Egypt	1898	New Zealand	1874		

Table 15: Start date for data on primary education

In Adelman and Taft Morris (1988) there is a classification scheme for rate of spread of primary education for the years 1830-1850. The classification scheme as well as the ranking of countries in this respect is reported in the following:

1. Countries where the percentage of children 6-14 in school probably increased by at least 15 percentage points during the period and by the end of the period over three-quarters of this age group were probably in school. (Denmark, Germany, Netherlands, Switzerland)

2. Countries where the percentage of children 6-14 in school probably increased by at

least 15 percentage points during the period but by the end of the period less than three-quarters, yet more than one-half, of this age group was probably in school. (Belgium, Canada?, France, Norway, Sweden, United States)

3. Countries where the percentage of children 6-14 in school probably increased by at least 10 percentage points during the period but by the end of the period less than a majority, yet more than one-third, of this age group was probably in school. Also included in this category are countries meeting the end-of-period criteria for category (1) or (2) where the probable increase in the percentage of children 6-14 in school was between10 and 15 percentage points. (Great Britain)

4. Countries where some significant spread of primary education took place during the period, with new laws passed, improvements in attendance, modest increases in enrollment, and lengthening of the school year among possible developments, but quantitative progress was not sufficient to meet criteria for categories (1) through (3). (Australia, Spain)

5. Countries where the spread of primary education during the period was quantitatively small and the qualitative improvements mentioned under Category (4) were not significant. (Argentina, Brazil, Burma, China, Egypt, India, Italy, Japan, Russia)

B.5 GDP Per Capita

The average annual growth rate for the period 1820-1913 is calculated using GDP data in 1990 international dollars from Maddison(1995). In 1913 the 23 countries were at different stages of industrialization, which is evident from the index of output of manufactures per head of population in Lewis (1978). Burma, China and Egypt are not present in the index. Mitchell (1995) reports that Burma and Egypt had an industrial sector that produced ten percent of GDP in 1950, while Cameron (1989) claims that China had not begun its industrialization process 1913. These countries are therefore given an index value of 1, the same as India.

	1820	1870	1913	Growth (%)	Lewis
Argentina		1311	3797	2.45	23
Australia	1528	3801	5505	1.37	75
Belgium	1291	2640	4130	1.25	73
Brazil	670	740	839	0.24	2
Burma			635	-0.13	1
Canada	893	1620	4213	1.66	84
China	523	523	688	0.29	1
Denmark	1225	1927	3764	1.20	46
Egypt			508	-0.01	1
France	1218	1858	3452	1.11	46
Germany	1112	1913	3833	1.33	64
Great Britain	1756	3263	5032	1.13	90
India	531	558	663	0.27	1
Italy	1092	1467	2507	0.89	20
Japan	704	741	1334	0.68	6
Netherlands	1561	2640	3950	0.99	44
New Zealand		3115	5178	1.16	66
Norway	1004	1303	2275	0.87	39
Russia	751	1023	1488	0.73	9
Spain	1063	1376	2255	0.80	15
Sweden	1198	1664	3096	1.02	50
Switzerland		2172	4207	1.51	64
United States	1287	2457	5307	1.52	100

Table 16: GDP per capita 1820-1913